BY: Infinity Supercritical Staff EG TAGS: Ultrasonic Oil Extraction, Cannabis, Oil Concentrates

Techniques For Extraction Of Bioactive Compounds From Plant Materials

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Technology Review | Blog | Industry Series | September 2017 9/1/2017

Techniques for extraction of bioactive compounds from plant materials

Azmir, J., Zaidul, I. S. M., Rahman, M. M., Sharif, K. M., Mohamed, A., Sahena, F., ... & Omar, A. K. M. (2013). Techniques for extraction of bioactive compounds from plant materials: a review. Journal of Food Engineering, 117(4), 426-436.

http://www.sciencedirect.com/science/article/pii/S0260877413000277

This review will go over bioactive compounds in plants, their classification, their extraction via conventional and non-conventional means, and bringing bioactive materials from plant to a commercial product.

The most important factors in extraction techniques are the matrix properties of the plant, solvent type, temperature, pressure, and extraction time.

Conventional methods include more traditional means of extraction using solvents solvating power with different temperatures and mechanical means of mixing, while non-conventional include other ways to increase the solvating power and reduce the amount of solvent used, usually making them more environmentally friendly and more selective.

Most bioactive compounds found in plants are secondary metabolites, which mean they don't contribute to the overall growth and development, but are believed by the plant and evolution to help the plant survive and overcome local challenges. The simple definition is any secondary plant metabolite that elicits a pharmacological or toxicological effect in humans or animals.

Some examples of this are floral compounds that encourage or discourage certain species of fauna to interact with the plant, or possibly toxins that dissuade herbivores from eating the plant.

Almost all bioactive compounds can be placed into three main categories; terpenes and terpenoids, alkaloids, and phenolic compounds.

Conventional ways to get bioactive compounds involved passing solvents through the bed of the plant in various ways, either through evaporation and then condensation, or direct passing through. Usually this involved hot temperatures which can degrade certain molecules, low ending concentrations, and long extraction times.

To decrease extraction times, increase yields, increase purity of ending product, and being more sensitive to the bioactive compounds, non-conventional extraction methods were developed which include: ultrasound assisted extraction, enzyme-assisted extraction, microwave-assisted extraction, pulsed electric field assisted extraction, supercritical fluid extraction, and pressurized liquid extraction.

Ultrasonic waves cause a phenomenon called cavitation when traversing through liquids where bubbles are produced, grow, and then collapse. During this process the kinetic energy is turned into heat and can heat the bubbles to incredibly high temperatures and pressures till they collapse. This accelerates mass transfer and allows for more access of the solvent to cell materials in plant parts through breaking of the cell wall.

This method increases extraction efficiencies without the need of thorough mixing or hot solvent. In most cases it leads to less solvent being used, lower energy consumption, better yields, and lower extraction times.

Enzyme-assisted extraction employs the use of enzymes to help free bioactive molecules possibly from hydrogen or hydrophobic bonding and uses enzymes like cellulase and pectinase to break the cell wall and hydrolyze structural polysaccharides and lipid bodies.

This type of extraction comes in handy when extracting fragile bioactive compounds from seeds and allow for water to be used as a solvent in certain processes that would need the higher solvating power of organic solvents.

Microwave-assisted extraction uses changing electric and magnetic field to impact polar molecules and heat them up, which increases mass transfer.

This technique allows for some selectivity in which molecules are heated and thus grabbed more by the solvent, decreases temperature gradients, and increases extraction yield of intact organic and organometallic compounds.

Pulsed-electric field extraction causes a potential through the membrane of the plant cells, which causes molecules to separate according to their charge. As they accumulate, they increase repulsion forces and can weaken the membrane to the point of breaking which increases the release of compounds from the plant matrix.

This technique allows for the release of bioactive compounds without increasing temperature at all and is chosen to increase extraction yields of highly heat sensitive compounds.

Supercritical fluids can be achieved when a compound is heated and pressurized past both it's critical temperature and pressure and there is no specific gas/liquid properties. This means the fluid retains it's gas-like diffusion, viscosity, and surface tension, and its liquid-like density and solvating power.

Normally, CO_2 is used due to its low critical temperature (87.8 degrees F) and low critical pressure (1073.3 psi), but it does have some limitations due to it's low polarity. This can normally be overcome by adding small amounts of a polar compound like ethanol.

Supercritical fluid extraction's main advantages is it's high diffusion coefficient and low viscosity allows for high penetration into the plant matrix, the tunability of the density and thus solvating power to certain compounds, the ease of removal of the solvent via depressurization, low critical temperature (with CO2) and thus low impact on heat sensitive molecules, lower use of organic solvent, and reusability of the fluid minimizing waste.

Pressurized liquid extraction uses higher temperatures and pressures of usually organic solvents to decrease extraction times and thus decrease solvent use. It's found to be quite effective and battles supercritical fluid extraction in the extraction of polar molecules.

Finally, some details on how we go from plant to a commercial product. First a plant species of interest in chosen through preliminary screening of traditionally used plants. This screening involves confirming the actual validity of their use for whatever physiological effect.

Next the toxicity of the plant is assessed to see if there are any side effects or other components that could cause issues with residual amounts from extraction.

Then, extraction of the plant sample and isolation of different compounds to high purity is done using the extraction techniques described above. From here biological testing is done on the individual components to find which cause the physiological response determined before. Sometimes when no clear active compound arises the combination of different compounds is tested to see if together they impart a synergistic effect.

Once an active compound or mixture is found, testing is done again first on animals and then moving to human studies to confirm the individual components affect, strength, and correct dosage for the desired effect.

Finally, after passing safety and toxicity studies as well as showing statistically significant benefits, cost-effectiveness and sustainability of industrial production is investigated to finally confirm a potential commercial product.